Steady Flow Water Surface Profile Computation
Using HEC-RAS (Basic)

Objectives

The objective of the course is to enable the participants to perform water surface profile computations using computer program HEC-RAS in a sound and effective manner.

Topics will include concepts of open channel flow, data requirements, basic input requirements, output analysis, application of bridge and culvert routines, and floodway determination. Participants will have an opportunity to prepare input and analyze output during workshops.

Monday: **Modeling River Hydraulics with HEC-RAS**

8:00 – 9:00 a.m. **INTRODUCTION**

9:00 – 10:00 a.m. 1.1 Lecture: **WATER SURFACE PROFILE CALCULATION**

Classifications of open channel flow; velocity distribution in a channel; energy principles; cross section subdivision for conveyance calculations; friction loss equations; contraction and expansion losses; computational procedure; critical depth determination; and applications of the momentum equation.

10:00 – 10:15 a.m. Break

10:15 – 11:00 a.m. 1.2 Lecture: **RESISTANCE TO FLOW**

Discussions about Manning's equation; uniform flow equations; methods for computing n values: tables, pictures, and equations; examples of calibrated n values for various streams.

11:00 - 12:00 p.m. 1.3 Lecture: **GEOMETRIC DATA REQUIREMENTS FOR WATER SURFACE PROFILE CALCULATIONS**

Study limit determination; defining the river system schematic; cross section geometry and locations; optional cross section properties: ineffective flow areas, levees, and blocked obstructions; defining the reach lengths between sections; energy loss coefficients; stream junction data.

12:00 - 1:00 p.m. **LUNCH**

1:00 - 2:00 p.m. 1.4 Lecture **STEADY FLOW DATA REQUIREMENTS**

Discussions about flow regime; boundary conditions; discharge information.

2:00 - 2:15 p.m. Break

2:15 - 3:15 p.m. 1.5 Lecture: **STEPS IN DEVELOPING A HYDRAULIC MODEL WITH HEC-RAS**

Starting HEC-RAS; steps in developing a hydraulic model: starting a new project, entering geometric data, entering steady flow data, performing the computations, viewing and printing results; getting and using help.

3:15 - 5:00 p.m. 1.6 Workshop: **CALCULATION OF WATER SURFACE PROFILES**

Students will learn to enter data into HEC-RAS; perform the hydraulic computations; and view results.

Tuesday:	**HEC-RAS Bridge Analysis**	
8:00 - 8:30 a.m.	**REVIEW WORKSHOP 1.6**	
8:30 - 9:15 a.m.	2.1 Lecture:	**VIEWING RESULTS**
	Viewing results; cross section plots; profile plot; X-Y-Z plot; summary tables; errors, warnings, and notes.	
9:15 - 9:30 a.m.	Break	
9:30 -10:45 a.m.	2.2 Lecture:	**HYDRAULICS OF BRIDGE WATERWAYS**
	Nature of flow through bridges; components of bridge losses; cross-section locations; defining ineffective flow areas; contraction and expansion losses.	
10:45 – 11:00 a.m.	Break	
11:00 –12:00 p.m.	2.3 Lecture:	**SELECTING A BRIDGE MODELING APPROACH**
	Available approaches to bridge loss computations within HEC-RAS; Selecting the appropriate bridge modeling approach for various situations of low flow bridge hydraulics; selecting the appropriate bridge modeling approach for various situations under high flow bridge hydraulics.	
12:00 –1:00 p.m.	**LUNCH**	
1:00 – 2:00 p.m.	2.4 Lecture	**APPLICATION OF HEC-RAS TO BRIDGE HYDRAULICS**
	Entering and editing bridge data; defining a bridge modeling approach; bridge modeling options; example bridge application; pertinent bridge output.	
2:00 - 2:15 p.m.	Break	
2:15 - 5:00 p.m.	2.5 Workshop:	**BRIDGE COMPUTATIONS**
	Students will learn to enter and edit bridge data; perform bridge hydraulic computations; and review pertinent results.	

Wednesday:	**HEC-RAS Culvert and Multiple Opening Analysis**	
8:00 - 9:00 a.m.	**REVIEW:** Workshop 2.5	
9:00 - 9:15 a.m.	Break	
9:15 -10:15 a.m.	3.1 Lecture:	**OVERVIEW OF CULVERT HYDRAULICS**
	Definition of terms; input requirements: cross section locations, ineffective flow areas, expansion and contraction coefficients; inlet control; outlet control; solution logic.	
10:15 - 10:30 a.m.	Break	
10:30 -11:15 a.m.	3.2 Lecture:	**APPLICATION OF HEC-RAS TO CULVERT HYDRAULICS**
	Entering and editing culvert data; culvert modeling options; example culvert applications.	
11:15 - 12:00 p.m.	3.3 Workshop	**CULVERT ANALYSIS**
	Students will learn how to enter and edit culvert data, perform culvert hydraulic computations; and review pertinent output.	
12:00 -1:00 p.m.	Lunch	
1:00 - 2:00 p.m.	3.3 Workshop	**CULVERT WORKSHOP CONTINUED**
2:00 - 3:00 p.m.	3.4 Lecture	**MULTIPLE BRIDGE AND CULVERT OPENINGS**
	General modeling guidelines; multiple opening approach; divided flow approach; entering multiple opening data; multiple opening output.	
3:00 - 3:15 p.m.	Break	
3:15 - 5:00 p.m.	3.5 Workshop	**MULTIPLE OPENING ANALYSIS**
	Students will learn how to define multiple openings; enter multiple opening data; perform the computations; and view the pertinent results.	

Thursday: **HEC-RAS Optional Capabilities and Floodway Determination**

8:00 - 9:00 a.m.	**REVIEW**: Workshop 3.3 and 3.5	
9:00 - 9:15 a.m.	Break	
9:15 - 10:15 a.m.	4.1 Lecture:	**OVERVIEW OF OPTIONAL CAPABILITIES**
	Multiple plan analysis; cross section interpolation; mixed flow regime calculations; flow distribution calculations; Inline Weirs and Gated Spillways; and Bridge Scour Analysis.	
10:15 – 11:30 a.m.	4.2 Workshop:	**MIXED FLOW REGIME CALCULATIONS**
	Students will learn how to run the model in a mixed flow regime mode, and review pertinent results.	
11:30 – 12:00 p.m.	**REVIEW:** Workshop 4.2	
12:00 -1:00 p.m.	Lunch	
1:00 - 2:00 p.m.	4.3 Lecture	**IMPORTING HEC-2 DATA**
	Discussions will include how to import HEC-2 data into HEC-RAS; differences between the programs as it pertains to the imported data; major areas where data modifications will be necessary.	
2:00 - 2:15 p.m.	Break	
2:15 - 3:15 p.m.	4.4 Lecture:	**FLOODPLAIN AND FLOODWAY DETERMINATION**
	Floodway definitions; general guidelines; computer procedures; program input requirements for floodway calculations; available output.	
3:15 – 4:30 p.m.	4.5 Workshop:	**FLOODWAY DETERMINATION**
	Students will learn how to enter and edit encroachment data and perform a floodway analysis.	
4:30 - 5:00 p.m.	**REVIEW:** Workshops 4.5	

Friday: **HEC-RAS Trouble Shooting and Output Analysis**

8:00 – 8:45 a.m. 5.1 Lecture: **TROUBLE SHOOTING WITH HEC-RAS**

This lecture will provide students with information on how to interpret HEC-RAS output messages (errors, warnings, and notes); diagnose common data input mistakes; and how to use the HEC-RAS Log File to understand more about the computations and possible problems.

8:45 – 9:00 a.m. Break

9:00 -10:30 a.m. 5.2 Workshop **OUTPUT ANALYSIS**

This workshop will teach students how to analyze the HEC-RAS output in order to detect common hydraulic modeling problems.

10:30 -11:00 a.m. **POST-COURSE ASSESMENT**

11:00 –11:30 a.m. **ORAL CRITIQUE AND COURSE COMPLETION**